Radiation

* No one is sure about the effects of low doses of radiation
* In every animal species, radiation has been shown to cause mutations
* Reactions
* Chemical reactions
* Occur when bonds are broken and formed
* atoms remain unchanged, though may be rearranged
* involve only valence electrons
* associated with small energy changes
* reaction rate is influenced by temp, pressure, conc. & catalysts
* Nuclear Reactions
* Occur when nuclei emit particles and/or rays
* atoms are often converted into atoms of another element
* may involve protons, neutrons, & electrons
* associated with large energy changes
* reaction rate is not normally affected by temp, pressure or catalysts
* An [atom](http://localhost:26300/Conceptual_Physics/38_Nuclear%20Physics/01/sp.html) consists of a nucleus surrounded by electrons.
* The electrons are negatively charged. The atom is held in place by an electric force of attraction between the positively charged protons and negatively charged electrons.
* A positively charged electron is called a **positron** and can be found in beta radiation. A positron is also known as an **antiparticle** or a particle of **antimatter**.
* An atom that has more or less protons than normal or found in nature is called an [isotope](http://localhost:26300/Conceptual_Physics/38_Nuclear%20Physics/03/sp.html).
* **The force of attraction between the protons and neutrons is called the strong force.**
* **Strong nuclear force- acts on subatomic particles to hold the nucleus together**
* **overcomes electrostatic repulsion between protons**
* **To remove a proton or neutron from the nucleus of an atom, we must have a force that is greater than the strong force and therefore, work is required.**
* **The amount of work required to remove a proton or neutron is called the** [**binding force**](http://localhost:26300/Conceptual_Physics/38_Nuclear%20Physics/05/sp.html)**.**
* **The strong nuclear force acts on protons and neutrons within a nucleus to hold the nucleus together.**
* **Unstable protons and neutrons that emit radiation are called** [**radioactive**](http://localhost:26300/Conceptual_Physics/38_Nuclear%20Physics/15/sp.html)**.**

**Atom- the material stuff is made from- about 105 element**

**Transmutation-** the changing of one element to another

**Transuranium elements-** 93 and greater radioactive

**Nucleons-** the particles in the nucleus of the atom (protons & neutrons)

**Radioactivity-** spontaneously decompose

**Radiation**- penetrates biological tissues- leaves no marks, can’t be felt. It breaks down molecules in cells

**Radioisotopes -**isotopes of atoms with unstable nuclei, emit radiation to attain more stable atomic configurations

**Radioactive Decay-** The strong nuclear force acts on protons and neutrons within a nucleus to hold the nucleus together.

* **Background radiation is always present**

**Emissions**

* **positron emission-**
* **radioactive decay process involving emission of a positron**
* **electron capture- occurs when the nucleus of an atom draws in a surrounding electron- usually from the lowest energy level**
* Alpha decay 42He
* beta decay = 0-1e
* positron emission= 01 β
* electron capture = X-ray photon
* gamma emission 00γ
* Radioactive Decay
* Alpha and Beta are made up of particles while gamma is made up of energy.

**The uranium-238 decay series**

* **one of three series in which a radioactive isotope having a**

**long half-life undergoes a series of natural radio-active changes and ends as a stable lead isotope.**

* Radiation
* V. Hassell
* No one is sure about the effects of low doses of radiation
* In every animal species, radiation has been shown to cause mutations
* Radiation- continuously decay to form new elements- giving off high-energy radiation.
* **Ionizing- injure atoms**
* **cancer or genetic defects**
* Certain parts of the body are more sensitive

**Ionizing Radiation-** Radiation which causes the things which come in contact with radiation to become radioactive.

**Non-ionizing Radiation-**do not cause surrounding things to become radioactive

* Damage is dependent on
* **The type of cell and tissues- somatic/germ, thyroid/hands**
* **type of rad.-alpha, beta, gamma**
* **area or volume involved**
* **total dose & energy of radiation**
  + **time for the accumulation of the dose**

**When exposed to radiation**

* + **Somatic- (body cells) may cause cancer**
  + **Germ cells-(egg & sperm) affect the formation of children. Birth Defects**
  + Rad- measure of radiation dosage
* Rem- measure of the effect on humans
* Rem-Based on dosage and damage.
* Rem-Rads X Biological =Damage Factor
* Human Effects of Radiation
* Health- x-ray’s used
* 1940s -X-rays with dosages often 50 to 100 times those used today.
* As recently as the 1960s mammograms to detect breast cancer sometimes delivered more than 100 times the maximum allowed radiation dose today
* routine well-baby pediatric exams
* to diagnose & treat enlarged thymus glands
* X-ray exams of pregnant women - can safely deliver
* monitor lung collapse therapy for TB.
* As a result, adults and many children received repeated doses of ionizing radiation that today would be considered hazardous.

Human Testing

* **$4.8 million paid for human tests in 1940s-** Times-Picayune Nov 20 1996 A-4
* U.S. Govt.- injected 12 humans in the 1940’s with uranium & plutonium without their knowledge in a radiation experiment.
* See how human body reacts to atomic bombing
* scientists claim they were terminallly ill anyway and would not survive 10 years

**Chain Reactions**

* Theses nuclear chain reactions are self sustained which means they do not need additional **energy** once the reaction is started.
* These nuclear chain reactions is what makes nuclear **reactors** and **bombs**.

In [**fusion**](http://localhost:26300/Conceptual_Physics/38_Nuclear%20Physics/14/sp.html), two small nucleus are combined to form a larger nucleus.

* Nuclear fusion is the source of energy for the **stars**, like our sun.
* To achieve fusion, nucleus must be heated to **millions** of degrees.
* Half-life & chain Reactions

**Chain reaction -**a domino effect

**critical mass-** the amount of a fissionable material that will support a self-sustaining chain reaction

**Half-life - A is the time required for half the atoms in a radioactive sample to decay.**

**Every radioisotope has a characteristic half-life.**

* **Nuclear fission**
* **A neutron strikes U-235, splitting it & forming new elements -releasing several neutrons causing a chain reaction & releases a lot of energy**
* **the splitting of a heavy atom like Uranium or Plutonium.**
* **One pound(U-235)=1000 tons coal**
* **Problems**
* **Needs tritium (radioactive), which is not abundant and difficult to contain.**
* **It causes embrittlement**
* **High Thermal Pollution**

**Nuclear power plants**

* **control fission through neutron moderation and neutron absorption**
* **use nuclear fission to generate steam.**
* **steam is used to drive turbines that produce electrical power.**

**Embrittlement**

* **- the metals making up the nuclear power plant become brittle because of neutron bombardment and makes it unsafe**

**Decommissioned**

* **the shutting of a plant down by sealing the entire containment building for an indefinite period of time.**

**Types of Reactors**

* **Fission-Fuel-Uranium/Plutonium byproduct-radiation**
* **Fusion- Fuel = Hydrogen, Byproduct =helium(inert, nonradioactive)**
* **Breeder- creates more fuel than it consumes**
* **no longer considered a good choice for the future b/c**
* **Construction takes longer, needs multiple safeguards, must meet higher safety standards.**
* **expensive & relatively short supply**
* **Biggest Default on public bonds**
* **Fears, Medical affects**

**China Syndrome**

* **- a loss of coolant accident- After 45 sec, the core temperature will rise to 1480 degrees C.**
* **It can react to produce**
* **Hydrogen gas -explosive.**

**3 Mile Island**

* **human error, blocked valves, broken pumps-**
* **The reactor was partially uncovered & 50 % melted. Unknown amounts of radiation escaped.**
* **50,000 were evacuated.**
* **The Nuclear Regulatory Commission (NRC) required 300 safety improvements to nuclear reactors after the incident**

Leaks-

* From Weapons Plants- Hanford, WA & Savannah River
* **Insects radioactive, but don’t let it bug you. Times Picayune- Oct, 22, 1998**
* Washington state- close to Hanover Nuclear power plant
* officials claim radioactivity is slight & no threat
* ants, flying insects, tumble weeds, flies, gnats
* might indicate an increase in radioactivity in soil or ground water (claim it is from radioactive garbage)
* **Chernobyl- 1986**
* **A massive explosion blasted tons of hazardous materials high into the air**
* **By 1994 it caused 8,000 premature deaths**
* **Types of nuclear waste**
* **low level – slightly contaminated- clothing**

**high level- spent reactor fuel rods**

**disposal of radioactive wastes and thermal pollution are unsolved problems.**

* **Nuclear Waste**
* **no safe method of long term disposal and no permanent disposal site in the U.S.**
* **used to produce nuclear weapons**
* **we purchase it from other countries.**
* **Spent fuel rods removed from nuclear cores are stored in on-site pools**
* **Outdoor Cement Casks store spent nuclear rods- built to withstand missiles, earthquakes, etc.  
  Dry Cask storage-25 tons for 10,000 years**

**Atomic Bombs**

* **uncontrolled release of nuclear energy**
* **ceases when all fissionable nuclear material is used up.**
* **1945-1st bomb test & Hiroshima – Fission reaction**
* **Nagasake-killed over 200,000**
* **testing-atomic veterans/ships**
* [**http://www.youtube.com/watch?v=yjiWBkiBZQU**](http://www.youtube.com/watch?v=yjiWBkiBZQU)

Atomic Blast

* Heat rays cast a permanent shadow of a bridge rail
* Temp several million o C
* heat- 3 sec (1.5 miles-clothes spontaneously combust, wood burns from the inside out
* Pressure (Shock wave)
* Vacuum
* Depends on if it is an air blast or on the surface
* March 1, 1954- 23 atomic tests 1000 X more powerful than Hiroshima
* 1946-58 effect of radiation on ships, planes, goats, etc. Fallout landed on Rongelap Atoll-100miles off
* 2 days later -radioactive snow covered it
* 167 natives left - declared safe- returned & evacuated
* still radioactive -planning on clearing land to scrape & spread potassium over it
* People evacuated, returned & left due to radioactive illnesses.
* The atoll's soil remains contaminated by radioactive cesium, a metal by-product of the blast. For that reason visitors are told not to eat coconuts or anything else grown on the island. All of Bikini's food is imported.
* In 201o, Bikini Atoll is still deemed uninhabitable because of dangerous radiation levels. The native citizens remain displaced on nearby islands, compensated by the US Government.

In [**fusion**](http://localhost:26300/Conceptual_Physics/38_Nuclear%20Physics/14/sp.html), two small nucleus are combined to form a larger nucleus.

* **Process -powering the stars**
* **Millions of degrees are needed for the reaction to occur-**
* **cause a containment problem due to the high temperature and pressure needed.**

Geiger Counter-

* particles in tube are ionized by radiation striking them. The more radiation, the more ionization and the stronger the current which flows through the tube. A counter produces clicks as indicator of the radiation around
* Measuring Radioactivity

Electroscope

* detects electric charge- leaves repel when charged radiation causes charged air (ionization)

Cloud Chamber-

* alcohol in container with dry gas- ions formed (alspha produce a visible track in the cloud chamber

Bubble Chamber-

* liquid hydrogen at its boiling temp with reduction in pressure cause bubbles to appear along the parth of the particle. Condensation trails- (like path of jet air craft) are formed.

Hadron Collider

* The worlds largest
* Lies in a tunnel 27 kilometers (17 mi) around and 175 meters down. Franco-Swiss border near
* It is designed to collide opposing particle beams at high energy
* Hadron refers to particles composed of quarks

Particle Accelerators

* Use magnetic fields and electromagnetic waves to accelerate charged particles
* cyclotron- electromagnetic devise for acelerating protons and deutrons in a spiral path (electrodes switch charges)
* deutron- deuterium nuclide

Tracers- radioactive material whose path may be followed

* Detect ground water movement through soil
* paths of industrial pollutants in air & water
* shifting of sand along coastline
* test of durability of components & ID structural weaknesses of equipment
* medicidne- diagnosis & treatment
* irradiation of food-long term storage w/o refrigeration (kills bacteria & molds which cause spoilage.

Photosynthesis

* Green plants absorb carbon in the form of carbon dioxide. A % of this is C-14. Once the plant dies, the photosynthesis stops and no more CO2 is absorbed. The decay of C-14 continues. By measuring the amount of radioactivity of C-14 a once-living plant yields- its age can be determined. The half-life of C-14 is 5700 yrs.
* **The age of the earth is determined by measuring the quantity of uranium-238 and of lead or helium found in minerals. The amounts of carbon-14 and carbon-12 found in organic remains are used to estimate their ages up to 60 000 years.**
* **Iron -59 used to produce this image of a patient’s circulatory system**

PET-

* positron emission tomography- expensive- requires radionuclides w/short half-lifes
* must maintain a cyclotron to produce as needed

SPECT-

* single photon emission computed tomography diagnose malfunctions more accurately than X-ray move common place than PET

MRI

* Magnetic Resonance Imaging